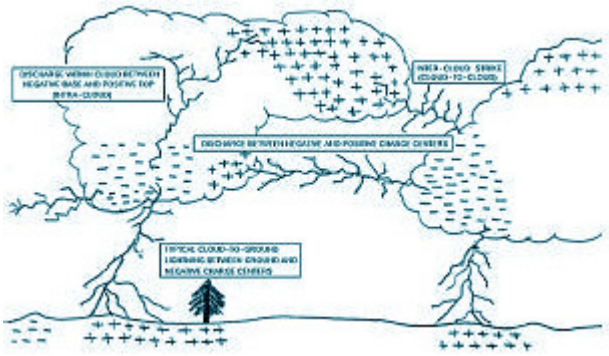
Lightning

What is Lightning?

Lightning is an electrical discharge in the atmosphere, very similar to a spark. It is the electrical breakdown of insulating air to provide a transient, conductive path along which a current can run to neutralize the charge.



Where and why does lightning occur?

Lightning mostly occurs in thunderstorms. Other situations in which lightning occurs are dust storms, blizzards, volcanic eruptions and nuclear explosions. It seems to be a phenomenon occurring in large volumes of particle clouds when they are being transported in the atmosphere.
Simplified, a thunderstorm has a positively charged top, a negatively charged lower section, and a small layer of positive charge at the cloud base which is carried up a little bit into the updrafts. We call the top (+) charged region the P region, the lower (-) charged region the N region, and the (+) charge nears the base, the p region.

Types of lightning discharges

In most cases, a thunderstorm discharges due to a lightning flash between the large N and P regions. This type of flash occurs within the cloud, and is not directly visible to our eyes. One usually just sees the cloud lighten up from the inside, and we call this sheet lightning. Such a flash is called an intracloud lightning discharge.

Lightning may also occur from the lower N region via the p region to ground. This is a cloud-to ground flash. Lightning, a flow of electrical current between the earth and storm clouds occurs as varying charges of positive and negative polarity build up in the atmosphere during a storm. The result is a discharge or current sent rushing toward the earth. As this downward force nears the earth's surface, positive charges rise up to meet it. As the negatively charged stepped leader thrusts toward the ground readying to discharge its energy, its path is erratic. Nearing the earth, positive charges are attracted by it and strain up from roof edges, lighting poles, antennas, etc. When the two opposing charge systems meet, they create a closed circuit. As

the path to the ground is completed, a flash is created.

WHAT HAPPENS DURING A LIGHTNING FLASH?

Consider a cloud-to-ground lightning flash, carrying negative charge down from the cloud to the ground. This lightning flash starts somewhere in the lower portions of the N region. When the electric field there becomes higher than a certain threshold value, a free electron (freed by cosmic radiation, usually) is being accelerated up to a point that it has enough kinetic energy to knock other electrons out of molecules, when it eventually strikes these. These other electrons start accelerating as well, and a chain-reaction takes place, called an electron avalanche. It is a rush of electrons, making a conductive path due to the leftover positively charged ions. This is the start of the so called stepped leader, precursor to the actual lightning discharge.

This stepped leader advances in steps of a few meters at a time, in the general direction of the ground below. During each step, electron avalanches occur away from the highly (-) charged tip. Now, free electrons initiating avalanches are being produced by photo ionization, as the tip of the leader emits light. At some points, several avalanches are produced, and the leader branches at such a point. While the stepped leader zips downwards at a rate of about 10000 m/s, charge is being deposited along the channel. When the leader approaches ground, the electric field rises and (+) charged filaments of charges called steamers shoot upward from any object residing there (usually a tall structure like a tree, a building, etc.). When one of these streamers connects with the stepped leader, a short circuit occurs, and charge starts to flow downward through the new channel. First, the charge nearest to the shortage point starts moving, later charge higher up in the channel moves. The current rises to several 10 KA, up to sometimes more than 100 KA. This immense current flow heats the channel, causing an explosion, a shock wave, and an intense light flash, which we see as lightning.

The top part of a lightning flash can't connect to anything physical in the cloud, as the cloud itself is not conductive. In this respect, a lightning flash is totally different from a spark. The cloud is never directly connected to ground electrically (just like you can't connect a string in the air, for instance - there's nothing to connect it to). Rather, the lightning channel branches out inside the cloud as a tree-like structure, and draws free electrons to it, freed from cloud particles by the high electrical field.
After a lightning flash has occurred, the storm cloud will recharge itself in a certain amount of time, depending on the activity of the storm. Some storms produce nearly continuous lightning (over 100 flashes per minute), some others produce just a single flash during their entire lifetime of about 1 hour or so.

SURGES: A BETTER HALF OF LIGHTNING EFFECTS

The direct Strike of Lightning

A direct lightning strike to an unprotected building can be catastrophic. Packing up to 100 million volts of electricity and a force comparable to that of a small nuclear reactor, lightning has the power to rip through roofs, explode walls of brick and concrete and ignite deadly fires. In addition to structural damage, lightning surges throughout power lines causing wire damage and destruction of valuable electronic equipment including computers, televisions, stereos, security systems.

The Indirect Strike of Lightning:

True, people may never, or rarely, experience, direct lightning strikes on exposed, in-building cable feeding into their equipment. However, it is not uncommon to find computer equipment being fed by buried cable. In this environment, a lightning strike, even several miles away, can induce voltage/current surges, which travel through the ground and induce surges along the cable, ultimately causing equipment failure. The equipment user is undoubtedly aware of these failures but usually does not relate them to the occurrence of lightning during thunderstorm activity since the user does not experience a direct strike.

What damage does lightning do?

Lightning strikes can kill people, knock out radio communications, electrical power, and destroy houses or trees. How exactly does this happen?

Electronic equipment is extremely susceptible to transient voltages and surge currents due to its relatively fragile semiconductor construction. AC supply lines, by their very nature of being a power carrier, interconnect industrial, commercial, and residential areas, buildings, and equipment. Every load being switched on or off creates some sort of electrical noise and voltage fluctuation. These transients and surges are then carried through the supply lines to all of the other loads in the vicinity. As the transients and surges increase in level, their destructive power is carried further in distance thereby reaching more sensitive electronic equipment. Every electronic device connected to the AC supply lines should have protection against these transient voltages and surge currents to ensure a longer service life.

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It is unfortunate, but a fact of life, that computers, computer related products and process control equipment found in premises data communications environments can be damaged by high-voltage surges and spikes. Such power surges and spikes are most often caused by lightning strikes. However, there are occasions when the surges and spikes result from any one of a variety of other causes. These causes may include direct contact with power/lightning circuits, static buildup on cables and components, high energy transients coupled into equipment from cables in close proximity, potential differences between grounds to which different equipment's are connected, miswired systems and even human equipment users who have accumulated large static electricity charge build-ups on their clothing. In fact, electrostatic discharges from a person can produce peak Voltages up to 15 kV with currents of tens of Amperes in less than 10 microseconds.

Semiconductors are prevalent in such equipment. A lightning induced surge will almost always surpass the voltage rating of these devices causing them to fail. Specifically, lightning induced surges usually alter the electrical characteristics of semiconductor devices so that they no longer function effectively. In a few cases, a surge may destroy the semiconductor device. These are called "hard failures." Computer equipment having a hard failure will no longer function at all. It must be repaired with the resulting expense of "downtime" or the expense of a standby unit to take its place.

In several instances, a lightning-derived surge may destroy the printed traces in the printed circuit boards of the computer equipment also resulting in hard failures.

Along with the voltage source, lightning can cause a current surge and a resultant induced magnetic field. If the computer contains a magnetic disk then this interfering magnetic field might overwrite and destroy data stored in the disk. Furthermore, the aberrant magnetic field may energize the disk head when it should be quiescent.

Some computer equipment may have magnetic relays. The same aberrant magnetic fields, which cause disk crashes, may activate relays when they shouldn't be activated, causing unpredictable, unacceptable performance. Finally, there is the effect of lightning on program logic controllers (PLCS), which are found in the manufacturing environment. Many of these PLCs use programs stored in ROMS. A lightning-induced surge can alter the contents of the ROM causing aberrant operation by the PLC.

In a way, such induced surges are analogous to chronic high blood pressure in a person; they are "silent killers." In the manufacturing environment, long cable runs are often found connecting sensors, PLCs and computers. These cables are particularly vulnerable to induced surges.

However during a lightning storm magnetic and electric fields are generated and often associated with a sudden change in the electrical supply. These events contribute to or directly cause the failure of sensitive electrical equipment, such as computers, and televisions. Power and data lines often provide a path for excess current to travel along therefore a building does not need to be struck directly by lightning to result in costly damage. Unfortunately this is sometimes overlooked when planning for protection.

When a person is struck by lightning the chances are about 50% that it will be fatal. Usually, the lightning enters the head or one of the ears. Contrary to what one might think, lightning usually strikes out of the body skin again after a few centimeters, because it is a highly transient electrical current, and these flow mostly at the surface of conducting material (like flesh). However, a person usually suffers cardiac arrest, apart from burns, temporary blindness and deafness. A strike can have profound effects on someone's life, if the person survives. In many cases neurons are permanently damaged.

Facts:

1. Lightning... Packs between 35,000 to 40,000 amperes of current.
2. Can generate temperatures as high as 50,000 degrees Celsius.
3. Falls somewhere on the earth every second.
4. Travels as far as 40 miles.
5. Can, and does strike the same place twice.
6. Causes billions of dollars in property damage each year, many times resulting in fire and total property loss.

THINGS YOU SHOULD KNOW..

Radio communication sights are particularly prone to lightning strikes.

The effects of a lightning strike are determined by both the magnitude and waveform of the current discharge. The amount of damaged suffered by equipment connected to data and signal lines is rapidly increases with the high installation density of computers, telecommunications and process control systems.

Modern telephone switching and PABX systems are particularly susceptible to damage from lightning induced transitions. Not only line circuits require protection but also telephone extensions that cross protection boundaries are especially venerable and must be protected.
Metal oxide varsities (MOV) are traditionally used for protection of LV, MV and HV power circuits. MOV's have exceptional surge handling capability and can handle an 8,000A 8/20us impulse. MOV's do however have a lifetime and need to be cheeked regularly.

Most surge protection components are rated in terms of their 8/20us current handling capability. This is a high-energy pulse and severely tests the component. You can compare the performance of surge protection devises by comparing their 8/20us capability.

Beware of residual voltage speciation derived from voltage injection (1.2/50us) tests only. The results appear

impressive but there is no energy to be dissipated from the voltage pulse only. This is not representative of a real world situation.

A transient surge protector is a device, which is typically used to protect electronic equipment from damage or destruction caused by transient voltages and surge currents. These destructive transients most often attack equipment through power input lines, signal input and output lines, data lines, and any other wire coming into or going out of a chassis containing electronics.

For safety of the human beings and the equipment, a good earthing with lowest possible resistance is the lifeline of the Lightning Protection System. Good earth pits as per BIS / IEC specifications are made, using Copper Plates / Rods or GI Plates / Pipes, dug deep in the ground in different configurations. Use of EARTH CONDUCTIVITY ENHANCEMENT COMPOUND not only makes the pits maintenance free, but also improves the soil conductivity by 3 - 20 times. Low resistance earth pits, < 5 ohms for lightning and < 1 ohm for equipment are normally recommended. Rocks have high resistance and digging for placement of Plates is a difficult proposition. In order to facilitate the same, three pure Copper Rods, greater than 12 mm in diameter, placed in an equilateral triangle configuration, duly interconnected inside the rock, provide good earthing with support of Special Soil Mix and Vegetable Soil filling in the pit holes. Soil conductivity enhancement compound poured in the three holes along the electrodes makes the pit maintenance free and also improves its conductivity.

The performance of any electrical equipment is optimum at its rated voltage. Both over / under voltages are harmful for the system. The under voltage reduces efficiency whereas the over voltage shortens the life. In case of very Low / High voltages, the telecom systems are powered by DG sets. Our Line Conditioner Unit meets the requirement of input voltage variation from 110V - 300V (Single phase) and 300V - 550V (Three phase). In India, there are large voltage variations in the mains power supply. We have attempted to provide stabilized 400V O/P for input voltage varying 320 to 500 Volts for three phase operation. The O/P voltage of the Conditioner will always be 400 + 5V, for 3 Phase Unit.

Voltage fluctuation problems are quite common in most of the countries in the world, particularly in India. A Three Phase Power System when unevenly loaded it causes different phase - neutral voltages and a heavy current in the neutral conductor. Due to dynamic nature of single-phase loads / utility it is not possible to rearrange the configuration of the system to make it symmetrical. To overcome these problems, Phase & Neutral Balancing System is a complete solution. Phase & Neutral Balancing System is a three-phase system, which is installed at the low voltage supply line between phases and neutral i.e. parallel to the impedances. PNBS due to its magnetic symmetry tries to establish neutral point symmetrical with respect to the phase

voltages. Thus, it equalizes the voltages in all the three phases and minimizes the neutral current.

When designing a complete system against lightning, all possible weak locations to be damaged by lightning have to be covered and prevented from damages. This includes any incoming or out coming metal conductors build in the existing installations. It is a must to protect all existing telephone lines, in the following cases: The devices connected to the telephone lines, such as modems, etc are very sensitive electronic equipment with a very low impedance and dielectric strength, and with a operating voltage under 100 volts.

EPMS is a unique device that helps in substantial reduction in electrical tariff and diesel expenses by incorporating three main units in itself: Phase Selector Unit, Line Conditioning Unit and AC Controller.

It comes in both single phase and three-phase version with capacity varying from 10KVA - 500 KVA.

Remote monitoring systems has been designed considering competition among Mobile / basic Government and Private telecom operators. At present scenario, after sales service is playing very important role in retaining the subscriber and to maintain the steady growth. Remote monitoring systems communicates complete status of Telecom site to service provider round the clock automatically. All electrical data related with Power Plant, Generator and Battery may be downloaded at remote centralize monitoring site in PC / CD or floppy with operator sitting at remote centralize monitoring office. Operator may monitor any N nos. of Telecom Sites continuously round the clock.